2/20/2006

RISK EVALUATION MANUAL 2006 PROPOSED UPDATES

The Risk Evaluation Manual (REM) was released by the Department of Environmental Quality in July 2004. Since REM's release, the Department has identified a handful of necessary corrections, updates, and clarifications. As part of the Department's commitment to maintain the REM as scientifically current, these proposed updates are the first in what is intended to be a regular update and revision process. The proposed updates and revisions are described here and are made available for public comment. Pending review and consideration of the comments received, the proposed changes will be finalized and a revised version of REM will be released for use.

The discussion of the proposed changes is organized as follows: revisions to toxicity values for selected chemicals, software revisions, and document revisions.

Submit written comments on the proposed revisions by 5 p.m. MST, Wednesday, March 22, 2006, to:

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Comments also may be submitted to DEQ's Waste and Remediation Web Forum at *http://forums. Idaho.gov/forum/index.cfm?forumid=8.*

Toxicity Factor Revisions

- The toxicity values for the chemicals listed in Appendix D of the REM were reviewed. Any changes in the toxicity assessments in the primary data sources for these chemicals were evaluated and changes to the REM database were made. The seventeen chemicals for which changes have occurred include: Barium, Chloroform, Chloromethane, Dibenzofuran, 1,3-Dichlorobenzene, 1,2-Dichloroethane, Ethylene Dibromide, MTBE, 2, 3, and 4- Nitroaniline, Tetrachloroethylene, Toluene, 1,2,4-Trichlorobenzene, Trichloroethylene, 1,2,4-Trimethylbenzene, and 1,3,5-Trimethylbenzene. The rationale for the changes in the toxicity values is provided below.

1. Barium

   The oral reference dose (RfD) for barium in EPA's IRIS database has changed from 0.07 mg/kg-day to 0.2 mg/kg-day. The oral RfD in the REM manual has been changed accordingly. EPA does not currently recommend use of a reference concentration RfC to assess inhalation exposure, although barium does exhibit toxicity via this exposure route. Previously an RfC of 0.0005 mg/m^3 was listed in EPA's HEAST database. This RfC was derived by a method that is not current with the inhalation methodology used by the RfD/RfC Work Group. The RfC converts to an inhalation RfD of 0.00014 mg/kg-day, which had been cited in the REM manual. Because of EPA's current position on the inhalation toxicity value for barium, the inhalation RfD for barium has been dropped from the REM manual.

2. Chloroform

   Cytotoxicity is considered the critical effect from oral exposure to chloroform, and cancer is considered to be a secondary development associated with regenerative hyperplasia following this toxic effect. Since there is a threshold for cytotoxicity, EPA has relied on a nonlinear dose-response approach and used margin of exposure analysis to determine that the oral reference dose is adequately protective against an increased risk of cancer. Accordingly, the oral RfD of 0.01 mg/kg-day will be relied upon to assess both cancer and noncancer risk associated with exposure to this chemical, and the previously used oral slope factor (SF) of 0.031 $(mg/kg\text{-}day)^{-1}$ has been dropped.

   For inhalation exposure, the current IRIS unit risk of 2.3E-5 per $(\mu g/m^3)$ converts to an inhalation SF of 0.081 mg/kg-day. This value replaces the previous REM manual value of 0.019 mg/kg-day, which had been developed by California EPA. The inhalation RfD of 0.014 mg/kg-day developed by EPA/NCEA, replaces the previous NCEA value of 0.00086 mg/kg-day.

3. Chloromethane (methyl chloride)

Previously the REM manual listed oral and inhalation slope factors for this chemical, citing the HEAST database. Regarding carcinogenicity, chloromethane would be considered in Group D (not classifiable as to its human carcinogenicity) based on EPA's previous guidance, Guidelines for Carcinogen Risk Assessment (U.S. EPA, 1986). According to the new guidance, Guidelines for Carcinogen Risk Assessment (EPA, 2005a), chloromethane would be classified as an agent whose carcinogenic potential cannot be determined. Accordingly, the slope factors have been dropped from the REM manual.

The previous inhalation reference dose of 0.086 mg/kg-day was based on an NCEA RfC. There is now an RfC of 0.09 mg/m^3 in the IRIS database, so the corresponding RfD of 0.026 mg/kg-day will replace the previous value in the REM manual. EPA does not currently support an oral RfD for this chemical, and notes that chloromethane exists primarily as a gas. Previously the REM manual did not list an oral RfD, so there is no change.

4. Dibenzofuran

The oral RfD has changed from 0.004 mg/kg-day to 0.002 mg/kg-day; the reference is NCEA. The inhalation RfD is also 0.002 mg/kg-day, based on route-to-route extrapolation.

5. 1,3-Dichlorobenzene

The oral RfD has changed from 0.0009 mg/kg-day to 0.03 mg/kg-day; the reference is NCEA. The inhalation RfD is also 0.03 mg/kg-day, based on route-to-route extrapolation.

6. 1,2-Dichloroethane

The previous oral reference dose of 0.03 mg/kg-day listed in the REM manual, was referenced as NCEA-derived; the new value, taken from the PPRTV database, is 0.02 mg/kg-day. The inhalation reference dose and the slope factors are unchanged.

7. Ethylene dibromide (EDB)

The slope factors previously listed in the REM manual were taken from the IRIS database. The values have been changed in IRIS. The oral slope factor, previously 85 $(mg/kg\text{-}day)^{-1}$, has been changed to 2.0 $(mg/kg\text{-}day)^{-1}$.
The previous inhalation slope factor of 0.77 $(mg/kg\text{-}day)^{-1}$ has also been changed to 2.0 $(mg/kg\text{-}day)^{-1}$.

The previous REM inhalation reference dose of 0.000057 mg/kg-day was taken from the HEAST database. The same value was used for the oral reference dose, based on route-to-route extrapolation. An oral reference dose for ethylene dibromide and a reference concentration are now available in IRIS, and the REM manual will list the oral RfD of 0.009 mg/kg-day and an inhalation reference dose of 0.0026 mg/kg-day based on the IRIS RfC of 0.009 mg/m^3.

8. MTBE

   The previous REM oral slope factor of 0.0033 $(mg/kg\text{-}day)^{-1}$ and inhalation slope factor of 0.00035 $(mg/kg\text{-}day)^{-1}$ were developed by California EPA. These numbers have been changed as a result of a data entry error. The REM values have been changed accordingly; the oral and inhalation slope factors are now 0.0018 and 0.00091$(mg/kg\text{-}day)^{-1}$, respectively.

9. 2-Nitroaniline

   The inhalation RfD has been rounded from 0.0000286 mg/kg-day to 0.00003 mg/kg-day. The oral RfD is unchanged.

10. 3-Nitroaniline

    The REM manual oral slope factor has been changed from 0.038 $(mg/kg\text{-}day)^{-1}$ to 0.021 $(mg/kg\text{-}day)^{-1}$, and the reference is the PPRTV database. The inhalation RfD of 0.0003 mg/kg-day is based on a PPRTV RfC of 0.001 mg/m^3. The oral RfD is unchanged.

11. 4-Nitroaniline

    The REM manual oral slope factor has been changed from 0.038 $(mg/kg\text{-}day)^{-1}$ to 0.021 $(mg/kg\text{-}day)^{-1}$, and the reference is the PPRTV database. The inhalation RfD of 0.001 mg/kg-day is based on a PPRTV RfC of 0.004 mg/m^3. The oral RfD has changed from 0.0003 mg/kg-day to 0.003 mg/kg-day, and the reference is the PPRTV database.

12. Tetrachloroethylene

    The inhalation RfD previously listed in the REM manual was 0.17 mg/kg-day. This number was cited as being from NCEA. The number has been replaced by a new inhalation RfD of 0.01 mg/kg-day, developed by California EPA. The cancer slope factors remain unchanged.

13. Toluene

The REM manual previously listed an oral RfD of 0.2 mg/kg-day and an inhalation RfD of 2.86 mg/kg-day, citing NCEA for both values. Recently EPA completed a toxicological review of this chemical (EPA, 2005b); as a result, the noncancer toxicity of this chemical is believed to be greater than was reflected by the previous toxicity values. EPA developed a new RfD of 0.08 mg/kg-day and an RfC of 5 mg/m^3 (which converts to an inhalation RfD of 1.43 mg/kg-day). Accordingly the new RfDs have replaced the previous values in the REM manual.

14. 1,2,4-Trichlorobenzene

The inhalation RfD was based on an RfC from EPA's PPRTV database; the RfC was retired on 10/16/2005. EPA does not currently support an RfC for this chemical. As a result the inhalation RfD has been dropped from REM. The oral RfD of 0.01 mg/kg-day remains unchanged.

15. Trichloroethylene

The EPA (2001) external review draft trichloroethylene risk assessment presents a cancer potency range for this chemical, for both oral and inhalation exposure. Previously the REM manual listed oral and inhalation slope factors representing the midpoint of this range. However, Region 10 EPA currently recommends the high end of the oral and inhalation cancer potency range for use in risk assessments, in order to be sufficiently protective (U.S. EPA Region 10, 2004). Accordingly, in the REM manual both oral and inhalation slope factors for TCE have been changed to 0.4 $(mg/kg\text{-}day)^{-1}$. The oral RfD of 0.0003 mg/kg-day and inhalation RfD of 0.01 mg/kg-day are unchanged.

16. 1,2,4-Trimethylbenzene (pseudocumene)

The previous oral and inhalation reference doses were taken from the PPRTV database, and have been retired from that database. The Superfund Technical Support Center (STSC), based on a Quantitative Structure-Activity Relationship (QSAR) analysis, has recommended to IDEQ that the oral RfD for 2,6-toluenediamine be used as a surrogate for the retired 1,2,4-trimethylbenzene oral RfD (Personal Communication, 2005). The oral RfD for 2,6-toluendiamine, taken from the 1997 HEAST database, is 0.2 mg/kg-day. This value replaces the previous REM value. The STSC does not recommend route-to-route extrapolation to derive an inhalation RfD, so 1,2,4-trimethylbenzene will now have an RfD only for oral exposure.

17. 1,3,5-Trimethylbenzene

The previous oral and inhalation reference doses were taken from the PPRTV database. These values were retired from the PPRTV database on 6/25/05. The Superfund Technical Support Center (STSC), based on a Quantitative Structure-Activity Relationship (QSAR) analysis, has recommended that the oral RfD for 2,5-toluenediamine be used as a surrogate for the retired 1,3,5-trimethylbenzene oral RfD (Personal Communication, 2005). The oral RfD for 2,5-toluendiamine, taken from the 1997 HEAST database, is 0.6 mg/kg-day. This value replaces the previous REM value. The STSC does not recommend route-to-route extrapolation to derive an inhalation RfD, so 1,3,5-trimethylbenzene will now have an RfD only for oral exposure.

References

Personal communication (2005). Teresa Shannon, Superfund Technical Support Center, National Center for Environmental Assessment, U.S. EPA, Cincinnati, OH. August 2, 2005.

U.S. EPA. (2005a) Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum, Washington, DC; EPA/630/P-03/001B.

U.S. EPA. (2005b) Toxicological review of toluene in support of summary information on the Integrated Risk Information System (IRIS). September, 2005. EPA/635/R-05/004.

U.S. EPA Region 10. (2004) Statement of the Status of Trichloroethylene (TCE) in Risk Assessments. Region 10 Office of Environmental Assessment, Risk Evaluation Unit. May 13, 2004.

U.S. EPA. 2001. Trichloroethylene Health Risk Assessment: Synthesis and Characterization (External Review Draft). U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC. EPA/600/P-01/002A, 2001.

U.S. EPA. (1986) Guidelines for carcinogen risk assessment. Federal Register 51 (185):33992-34003.

Software Revisions and Notes

- The first page of the fate and transport input parameter sheet, which deals with inputs for the vapor intrusion pathway evaluation using the Johnson and Ettinger model (JEM) has been revised.

  Parameter headings for several parameters have been modified to be more consistent with the terminology used by the USEPA (2004) in their spreadsheet implementation of the model.

  It was discovered that for several of the enclosed space input parameters the interdependence of the parameters, as developed in the JEM, was not fully implemented. These parameters included the equivalent crack width and the building crack ratio. This has been corrected. Because of their interdependence it was decided to fix the value of the equivalent crack ratio at 0.1 cm, equivalent to the default value used in USEPA (2004). The building crack ratio is then calculated but with a specified minimum value of 0.0005. This minimum value is what is suggested as a reasonable lower end of the range for this parameter by Johnson (2005).

  Several parameters which were represented in the original software as independent parameters that could be altered have now been modified to reflect their true status as calculated parameters. These parameters include the crack depth below grade (now equivalent to the depth below grade to bottom of enclosed space floor), the area of the enclosed space below grade, the total area of cracks, and the floor-wall seam perimeter.

  The input units used for the number of building air exchanges has been changed from exchanges per second to exchanges per hour, a more common unit of measure for this parameter. In addition, the default input value for non-residential buildings for this parameter has been changed from two (2) to one (1) exchange per hour. The revised value is more consistent with expected values in commercial buildings which are built to meet ventilation standards of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE 2004).

  The output of the software implementing the changes described above was validated against the output of the USEPA (2004) implementation of the JEM using identical input parameters. The calculated attenuation coefficients and intermediate calculations were identical.

  The net impact of the revisions to this portion of the REM software on the Initial Default Target Levels (IDTL) of volatile chemicals is a negligible increase in the IDTL value on the order of less than one (1) percent. The particular chemicals(?) for which these changes in values occurred are identified in the section “Document Revisions”.

- The original release of the REM software was developed with Visual Basic for Applications (VBA) as implemented in Excel 97. It was discovered after the release that certain features of the interface in the software were altered when run on more recent versions of Excel, including Excel 2000. These alterations are restricted to the Chemicals of Concern (COC) sheet and involve text in headings and buttons which present themselves as mirror images. The text typically will assume its normal configuration when a button is clicked but revert to its mirrored form when another button is clicked. This behavior appears to be due to changes in the language since the 1997 release but the specific source of the behavior has not been identified. The functionality of the sheet and the software is not impaired by this behavior. It is the goal of DEQ to eventually move away from an Excel platform for the software to a more universal Windows Visual Basic platform.

- Another problem that was identified but not corrected is that when the site name, preparer, and date are entered into a simulation and the simulation is saved as a new file, upon reopening the file that information is lost and must be reentered.

- The saturated zone retardation factor calculation was modified to permit the inclusion of Kd values from metals. In the original release only organic chemical K_{oc} values were able to be used in this calculation.

- A problem has been identified that affects sites where site-specific water hardness values are being used to calculate surface water criteria for selected metals. The problem arises if the site-specific hardness value is entered in Fate and Transport Parameter sheet 2 **after** the metals in question have been chosen in the COC sheet. In this case the recalculated numeric criteria (using the site-specific hardness value) will not be translated to the Surface Water Protection sheet and used in the calculation of allowable soil or groundwater concentrations. In addition the surface water criteria shown by clicking the toxicity properties button in the COC sheet will not reflect the recalculated value.

  The suggested work-around for this problem is to first identify during conceptual site model development whether surface water protection will be a critical pathway for the site of interest, whether metals with hardness dependant criteria are COCs, and whether hardness data has been or will be collected for the water body of concern. If all of these conditions apply then the measured hardness value should be entered in Page 2 of the Fate and Transport Parameters sheet when first **before** entering the chemicals of concern. This same strategy would also apply for site-specific pH data if pentachlorphenol is a COC and surface water is potentially impacted since the numeric criteria for this chemical is pH -dependant.

- Changes to the toxicity factors for the seventeen chemicals discussed above are incorporated into the software.

- The equations used to calculate hardness dependent metals surface water criteria as well as specific beneficial use criteria for select metals has been modified to reflect changes in the Numeric Criteria for Toxic Substances contained in IDAPA 58.01.01.210 of the Water Quality Standards and Wastewater Treatment Requirements which were implemented on 4/6/2005.

References

ASHRAE. 2004. Ventilation For Acceptable Indoor Air Quality. Standard 62.1. American Society of Heating, Refrigeration, and Air Conditioning Engineers.

Johnson, Paul C. 2005. Identification of Application-Specific Critical Inputs for the 1991 Johnson and Ettinger Vapor Intrusion Algorithm. Ground Water Monitoring and Remediation. Volume 25. No. 1. Pages 63-78.

USEPA. 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Prepared by Environmental Quality Management, Inc. for submittal to U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D. C. February 22, 2004.

Document Revisions

- Section 3.10.1 and Table 3-5. The values for the surface water toxics criteria referenced in this section, listed in Table 3-5 of the REM and included in the software have been updated to reflect changes in the numeric criteria for toxic substances contained in the Water Quality Standards and Wastewater Treatment Requirements (IDAPA 58.01.02.210) since the original release of the REM. The updates are primarily to a select group of metals. These changes involve modifications directly to a standard for a given beneficial use category or a change in the factors used in calculating criteria for hardness dependant metals. In one case, for inorganic mercury, the numeric criteria have been removed.

  Table 3-5 in the REM and the software will be modified to reflect the current version of the water quality standards found in IDAPA 58.01.02.210.

- Section 4.7.1. Page 4-11. Third Paragraph. Revised to read (with added text underlined): "For sites with considerable seasonal fluctuation in water table level, <u>depending on the data available and the nature of the fluctuations</u>, a yearly average depth <u>or a time weighted depth</u> may be <u>appropriate. The vadose zone depth that is estimated should also form the basis for the selection of soil samples to be used in evaluation of subsurface soil vapor emissions to indoor air.</u>

- A draft version of the proposed revisions to the IDTL table found in Appendix A of the REM is in Table 2 of this document. Chemicals whose values vary from those in the original REM release are highlighted. The different highlighted colors reflect the source of the change in value. Blue highlighted cells vary as a result of the previously described modifications to the Johnson and Ettinger model in the software. In all cases the resulting change is a slight increase in the IDTL value. The magnitude of the increase is typically less than 1 percent of the original value and not greater than 5 percent.

  Yellow highlighted cells vary primarily as a result of changes in the toxicity factors. Where the dominant pathway is via vapor intrusion, a small component may be attributable to the changes described above for the blue highlighted cells. Due to the chemical- and route of exposure- specific nature of the toxicological reassessments, no pattern exists as to either the direction or the magnitude of the change in the IDTL value compared to the value published in the original REM release. Table 1 summarizes the IDTL changes for the 17 chemicals with toxicity revisions.

Table 1. Summary of IDTL changes resulting from toxicity information revisions.

Chemical of Concern	Old Soil IDTL (mg/kg)	New Soil IDTL (mg/kg)	Change	Old GW IDTL (mg/l)	New GW IDTL (mg/l)	Change
1,2,4-Trichlorobenzene	6.92E-1	2.20	increase	7.00E-2	7.00E-2	none
1,2,4,- Trimethylbenzene	1.93E-1	39.3	increase	4.39E-1	2.09	increase
1,3,5- Trimethylbenzene	1.45E-1	129	increase	3.04E-1	6.26	increase
1,2- Dichloroethane	7.67E-3	7.71E-3	increase	5.00E-3	5.00E-3	none
1,3- Dichlorobenzene	2.29E-1	7.66	increase	9.39E-3	3.13E-1	increase
2- Nitroaniline	7.25E-2	7.25E-2	none	3.13E-2	3.13E-2	none
3- Nitroaniline	3.18E-3	5.75E-3	increase	1.47E-3	2.66E-3	increase
4- Nitroaniline	2.99E-3	5.42E-3	increase	1.47E-3	2.66E-3	increase
Barium	896	896	none	2.00	2.00	none
Chloroform	5.64E-3	7.83E-3	increase	1.80E-3	2.07E-2	increase
Chloromethane	2.31E-2	1.41	increase	4.30E-3	NA	remove
Dibenzofuran	6.10	3.05	decrease	4.17E-2	2.09E-2	decrease
Ethylene Dibromide	1.43E-4	1.43E-4	none	5.00E-5	5.00E-5	none
MTBE	3.64E-2	6.67E-2	increase	1.69E-2	3.10E-2	increase
Tetrachloroethene	2.88E-2	3.02E-2	increase	5.00E-3	5.00E-3	none
Toluene	4.89	4.89	none	1.00	1.00	none
Trichloroethene	2.88E-3	1.59E-3	decrease	3.32E-3	1.79E-3	decrease

Finally, the light orange highlighted cells represent changes due to typographical errors in IDTL values that were incorrectly transposed in the original release. This occurred for two chemicals, Aroclor 1254 and 1,1,1-Trichloroethane. In both cases the corrected values are lower than those originally published.

- Appendix C. Page C-1. Last Paragraph. First Sentence. Changed to read: If chemicals of concern at the site are non-volatile (chemicals with a dimensionless Henry's Law constant of less than or equal to 1×10^{-4} and a molecular weight exceeding 200 are generally considered non-volatile [EPA, 1996]), the indoor air pathway for both current and future conditions <u>will typically</u> be considered incomplete <u>but final determinations will be made on a case by case basis.</u>
- Appendix C. Page C-4. Second Paragraph. Appendix D should be Appendix <u>G.</u>

- Appendix C. Page C-4. Third Paragraph. First Sentence should read: For current conditions, if the soil and ground water within 100 feet of the structure are not impacted, there are no preferential vapor pathways, and the area is <u>not</u> paved, the pathway may be incomplete.

- Appendix C. Addition to Section C.6. Suggested References:

American Petroleum Institute. 2005. Collecting and Interpreting Soil Gas Samples from the Vadose Zone. A Practical Strategy for Assessing the Subsurface Vapor-to-Indoor Air Migration Pathway at Petroleum Hydrocarbon Sites. Publication Number 4741. November 2005.

- Appendix D. This table will be revised to reflect changes in the toxicity factors for the seventeen chemicals discussed earlier.

- Appendix F. Default Metal K_d Values. This section is intended to clarify the discussion on pages F-2 and F-3 in the REM regarding the source of default K_d values for metals.

  The following discussion regarding the source of the default K_d value selected will be inserted in Appendix F on page F-3 at the end of the section entitled **Saturated Zone**:

  The geochemical conditions represented by the default K_d values for selected metals are presented below:

  - Antimony: The value of 45 ml/g is taken from the USEPA (1996) document and is based on a pH value of 6.8.

  - Arsenic: The value of 25 ml/g is taken from the USEPA (1996) document and is based on a pH value of 4.9.

  - Barium: The value of 14 ml/g is taken from the USEPA (1996) document and is based on a pH value of 8.0.

  - Beryllium: The value of 23 ml/g is taken from the USEPA (1996) document and is based on a pH value of 4.9.

  - Cadmium: The value of 15 ml/g is taken from the USEPA (1996) document and is based on a pH value of 4.9.

  - Chromium (III): The value of 1200 ml/g is taken from the USEPA (1996) document and is based on a pH value of 4.9.

  - Chromium (VI): The value of 14 ml/g is taken from the USEPA (1996) document and is based on a pH value of 8.0.

  - Copper: The value of 40 ml/g occurs in the lower end of the range of published values from Baes, et. al. (1984) and USEPA (2005) and is similar to values calculated for a pH of 4.9 from empirical regression equations based on data for sandy low adsorbent sediments published by Hassan et. al. (1996).

- Lead: The value of 186 ml/g is taken from the USEPA (1999) document and is based on higher solution concentrations of lead (10-100 ug/l) and lower pH values (4.0-6.3).

- Manganese: The value of 50 ml/g is taken from the Baes, et. al. (1984) compilation and is in the lower end of their published range and close to the geometric mean.

- Mercury: The value of 0.4 ml/g is taken from the USEPA (1996) document and is based on a pH value of 4.9.

- Nickel: The value of 16 ml/g is taken from the USEPA (1996) document and is based on a pH value of 4.9.

- Selenium: The value of 2.2 ml/g is taken from the USEPA (1996) document and is based on a pH value of 8.0.

- Silver: The value of 0.1 ml/g is taken from the USEPA (1996) document and is based on a pH value of 4.9.

- Thallium: The value of 44 ml/g is taken from the USEPA (1996) document and is based on a pH value of 4.9.

- Zinc: The value of 16 ml/g is taken from the USEPA (1996) document and is based on a pH value of 4.9.

References

Baes, C.F. III, Sharp, R.D., Sjoreen, A.L., and R.W. Shor.1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture. Oak Ridge National Laboratory Report. ORNL-5786. Oak Ridge, Tennessee.

Hassan, S.M., Garrison, A.W., Allen, H.E., Di Toro, D.M., and G. T. Ankley. 1996. Estimation of Partition Coefficients for Five Trace Metals in Sandy Sediments and Application to Sediment Quality Criteria. Environmental Toxicology and Chemistry. Volume 15. Number 12. Pages 2198-2208.

United States Environmental Protection Agency. 1996. Soil Screening Guidance: Technical Background Document. Office of Solid Waste and Emergency Response. 9355.4-17A. EPA/540/R-95/128.

United States Environmental Protection Agency. 1999. Understanding Variation in Partition Coefficient, Kd Values. Volume II: Review of Geochemistry and Available Kd

Values for Cadmium, Cesium, Chromium, Lead, Plutonium, Radon, Strontium, Thorium, Tritium, and Uranium. Office of Air and Radiation. EPA-402-R-99-004B.

United States Environmental Protection Agency. 2005. Partition Coefficients for Metals in Surface Water, Soil, and Waste. Office of Research and Development. EPA/600/R-050/074. July 2005.

Table 2

(Draft) 2006 Revised Appendix A

Initial Default Target Levels

APPENDIX A

INITIAL DEFAULT TARGET LEVELS (IDTLs)

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INITIAL DEFAULT TARGET LEVELS (IDTLs)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Basis for Ingestion Target/ Inhalation Critical Receptor$_i$
1,1,1,2-Tetrachloroethane	4.09E-02	GWP[a]	GWP	2.15E-03	Ingestion	Risk-Based
1,1,1-Trichloroethane	1.18E+00	GWP	GWP	2.00E-01	Ingestion	MCL[b]
1,1,2,2-Tetrachloroethane	9.15E-04	GWP	GWP	2.79E-04	Ingestion	Risk-Based
1,1,2-Trichloroethane	1.41E-02	GWP	GWP	5.00E-03	Ingestion	MCL
1,1-Dichloroethane	3.48E+00	GWP	GWP	1.04E+00	Ingestion	Risk-Based
1,1-Dichloroethene	3.88E-02	GWP	GWP	7.00E-03	Ingestion	MCL
1,2,3-Trichloropropane	2.45E-04	GWP	GWP	2.79E-05	Ingestion	Risk-Based
1,2,4-Trichlorobenzene	2.20E+00	GWP	GWP	7.00E-02	Ingestion	MCL
1,2,4-Trimethylbenzene (pseudocumene)	3.93E+01	GWP	GWP	2.09E+00	Ingestion	Risk-Based
1,2-Dibromo-3-chloropropane	9.75E-04	GWP	GWP	2.00E-04	Ingestion	MCL
1,2-Dichlorobenzene	5.25E+00	GWP	GWP	6.00E-01	Ingestion	MCL
1,2-Dichloroethane	7.71E-03	Subsurface Soil	Child	5.00E-03	Ingestion	MCL
1,2-Dichloroethene-(cis)	1.93E-01	GWP	GWP	7.00E-02	Ingestion	MCL
1,2-Dichloroethene-(trans)	3.65E-01	GWP	GWP	1.00E-01	Ingestion	MCL
1,2-Dichloropropane	9.33E-03	Subsurface Soil	Child	5.00E-03	Ingestion	MCL
1,2-Diphenylhydrazine	9.48E-04	GWP	GWP	6.98E-05	Ingestion	Risk-Based
1,3,5-Trimethylbenzene	1.29E+02	GWP	GWP	6.26E+00	Ingestion	Risk-Based
1,3-Dichlorobenzene	7.66E+00	Subsurface Soil	Child	3.13E-01	Ingestion	Risk-Based
1,3-Dichloropropene-(cis)	2.45E-03	GWP	GWP	5.59E-04	Ingestion	Risk-Based
1,3-Dichloropropene-(trans)	2.45E-03	GWP	GWP	5.59E-04	Ingestion	Risk-Based
1,4-Dichlorobenzene	7.58E-02	Subsurface Soil	Child	7.50E-02	Ingestion	MCL
2,3,7,8-TCDD[h]	3.91E-06	Surficial Soil	Age-Adjusted	3.00E-08	Ingestion	MCL
2,4,5 TP (silvex)[i]	2.37E+00	GWP	GWP	5.00E-02	Ingestion	MCL
2,4,5-Trichlorophenol	7.38E+00	GWP	GWP	1.04E+00	Ingestion	Risk-Based
2,4,6-Trichlorophenol	4.36E-03	GWP	GWP	1.04E-03	Ingestion	Risk-Based
2,4,6-Trinitrotoluene	1.34E-02	GWP	GWP	1.86E-03	Ingestion	Risk-Based
2,4-Dichlorophenol	9.78E-02	GWP	GWP	3.13E-02	Ingestion	Risk-Based
2,4Dichlorophenoxyacetic acid	1.84E+00	GWP	GWP	1.04E-01	Ingestion	Risk-Based
2,4-Dimethylphenol	8.19E-01	GWP	GWP	2.09E-01	Ingestion	Risk-Based
2,4Dinitro-6-sec-butylphenol (Dinoseb)	1.63E-01	GWP	GWP	7.00E-03	Ingestion	MCL

INITIAL DEFAULT TARGET LEVELS (IDTLs)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Basis for Ingestion Target/ Inhalation Critical Receptor$_i$
2,4-Dinitrophenol	3.84E-02	GWP	GWP	2.09E-02	Ingestion	Risk-Based
2,4-Dinitrotoluene	2.90E-04	GWP	GWP	8.22E-05	Ingestion	Risk-Based
2,6-Dinitrotoluene	2.12E-04	GWP	GWP	8.22E-05	Ingestion	Risk-Based
2-Butanone (Methyl Ethyl Ketone)	1.18E+01	GWP	GWP	6.26E+00	Ingestion	Risk-Based
2-Chloronaphthalene	1.28E+02	GWP	GWP	8.34E-01	Ingestion	Risk-Based
2-Chlorophenol	3.65E-01	GWP	GWP	5.21E-02	Ingestion	Risk-Based
2-Chlorotoluene	1.57E+00	Subsurface Soil	Child	2.09E-01	Ingestion	Risk-Based
2-Methylnaphthalene	3.31E+00	GWP	GWP	4.17E-02	Ingestion	Risk-Based
2-Methylphenol	1.80E+00	GWP	GWP	5.21E-01	Ingestion	Risk-Based
2-Nitroaniline	7.25E-02	GWP	GWP	3.13E-02	Ingestion	Risk-Based
3,3-Dichlorobenzidine	1.83E-03	GWP	GWP	1.24E-04	Ingestion	Risk-Based
3-Nitroaniline	5.75E-03	GWP	GWP	2.66E-03	Ingestion	Risk-Based
4- Bromophenylphenylether	5.45E-03	GWP	GWP	3.72E-06	Ingestion	Risk-Based
4-Chloroaniline	1.26E-01	GWP	GWP	4.17E-02	Ingestion	Risk-Based
4-Methyl-2-pentanone	1.76E+01	GWP	GWP	8.97E+00	Ingestion	Risk-Based
4-Methylphenol	1.41E-01	GWP	GWP	5.21E-02	Ingestion	Risk-Based
4-Nitroaniline	5.42E-03	GWP	GWP	2.66E-03	Ingestion	Risk-Based
4-Nitrophenol	2.26E-01	GWP	GWP	8.34E-02	Ingestion	Risk-Based
Acenaphthene	5.23E+01	GWP	GWP	6.26E-01	Ingestion	Risk-Based
Acenaphthylene	7.80E+01	GWP	GWP	6.26E-01	Ingestion	Risk-Based
Acetochlor	1.12E+00	GWP	GWP	2.09E-01	Ingestion	Risk-Based
Acetone	1.74E+01	GWP	GWP	9.39E+00	Ingestion	Risk-Based
Acrolein	9.65E-03	GWP	GWP	5.21E-03	Ingestion	Risk-Based
Acrylonitrile	1.94E-04	GWP	GWP	1.03E-04	Ingestion	Risk-Based
Alachlor	1.05E-02	GWP	GWP	2.00E-03	Ingestion	MCL
Aldicarb	4.14E-02	GWP	GWP	1.04E-02	Ingestion	Risk-Based
Aldrin	2.11E-02	Surficial Soil	Age-Adjusted	3.29E-06	Ingestion	Risk-Based
Ammonia	4.15E+00	Subsurface Soil	Child	NA	NA	NA
Aniline	1.96E-02	GWP	GWP	9.80E-03	Ingestion	Risk-Based
Anthracene	1.04E+03	GWP	GWP	3.13E+00	Ingestion	Risk-Based
Antimony	4.77E+00	GWP	GWP	6.00E-03	Ingestion	MCL

INITIAL DEFAULT TARGET LEVELS (IDTLs)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Basis for Ingestion Target/ Inhalation Critical Receptor$_i$
Aroclor 1016	2.33E+00	GWP	GWP	7.30E-04	Ingestion	Risk-Based
Aroclor 1221	2.94E-03	GWP	GWP	2.79E-05	Ingestion	Risk-Based
Aroclor 1242	3.18E-03	GWP	GWP	2.79E-05	Ingestion	Risk-Based
Aroclor 1248	1.37E-01	GWP	GWP	2.79E-05	Ingestion	Risk-Based
Aroclor 1254	1.46E-01	Surficial Soil	Age-Adjusted	2.79E-05	Ingestion	Risk-Based
Aroclor 1260	1.47E-01	Surficial Soil	Age-Adjusted	2.79E-05	Ingestion	Risk-Based
Arsenic	3.91E-01	Surficial Soil	Age-Adjusted	1.00E-02	Ingestion	MCL
Atrazine	1.39E-02	GWP	GWP	3.00E-03	Ingestion	MCL
Azobenzene	1.30E-02	GWP	GWP	5.08E-04	Ingestion	Risk-Based
Barium	8.96E+02	GWP	GWP	2.00E+00	Ingestion	MCL
Benzene	1.78E-02	GWP	GWP	5.00E-03	Ingestion	MCL
Benzidine	5.37E-07	GWP	GWP	2.43E-07	Ingestion	Risk-Based
Benzo(a)anthracene	4.22E-01	Surficial Soil	Age-Adjusted	7.65E-05	Ingestion	Risk-Based
Benzo(a)pyrene	4.22E-02	Surficial Soil	Age-Adjusted	2.00E-04	Ingestion	MCL
Benzo(b)fluoranthene	4.22E-01	Surficial Soil	Age-Adjusted	7.65E-05	Ingestion	Risk-Based
Benzo(g,h,i)perylene	1.18E+03	Surficial Soil	Child	3.13E-01	Ingestion	Risk-Based
Benzo(k)fluoranthene	4.22E+00	Surficial Soil	Age-Adjusted	7.65E-04	Ingestion	Risk-Based
Benzoic acid	7.71E+01	GWP	GWP	4.17E+01	Ingestion	Risk-Based
Benzyl Alcohol	6.43E+00	GWP	GWP	3.13E+00	Ingestion	Risk-Based
Beryllium	1.63E+00	GWP	GWP	4.00E-03	Ingestion	MCL
BHC-alpha[c]	2.10E-04	GWP	GWP	8.87E-06	Ingestion	Risk-Based
BHC-beta	7.51E-04	GWP	GWP	3.10E-05	Ingestion	Risk-Based
BHC-gamma(Lindane)	8.96E-04	GWP	GWP	4.30E-05	Ingestion	Risk-Based
Bis(2-chloroethyl)ether	1.08E-04	GWP	GWP	5.08E-05	Ingestion	Risk-Based
Bis(2-chloroisopropyl)ether	3.11E+00	GWP	GWP	4.17E-01	Ingestion	Risk-Based
Bis(2-ethylhexyl)phthalate	1.18E+01	GWP	GWP	6.00E-03	Ingestion	MCL
Bromodichloromethane	2.68E-03	GWP	GWP	9.01E-04	Ingestion	Risk-Based
Bromoform	2.92E-02	GWP	GWP	7.07E-03	Ingestion	Risk-Based
Bromomethane	5.01E-02	GWP	GWP	1.46E-02	Ingestion	Risk-Based
Butyl benzyl phthalate	5.11E+02	GWP	GWP	2.09E+00	Ingestion	Risk-Based
Cadmium	1.35E+00	GWP	GWP	5.00E-03	Ingestion	MCL

INITIAL DEFAULT TARGET LEVELS (IDTLs)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Basis for Ingestion Target/ Inhalation Critical Receptor$_i$
Carbofuran	9.42E-02	GWP	GWP	4.00E-02	Ingestion	MCL
Carbon disulfide	5.97E+00	GWP	GWP	1.04E+00	Ingestion	Risk-Based
Carbon Tetrachloride	1.20E-02	Subsurface Soil	Child	4.69E-03	Indoor Inhalation	Age-Adjusted
Chlordane	1.53E+00	Surficial Soil	Age-Adjusted	2.00E-03	Ingestion	MCL
Chlorobenzene	6.18E-01	GWP	GWP	1.00E-01	Ingestion	MCL
Chloroethane	5.33E-02	GWP	GWP	1.93E-02	Ingestion	Risk-Based
Chloroform	7.83E-03	Subsurface Soil	Child	2.07E-02	Indoor Inhalation	Age-Adjusted
Chloromethane	1.41E+00	Subsurface Soil	Child	NA	NA	NA
Chlorpyrifos	2.84E+00	GWP	GWP	3.13E-02	Ingestion	Risk-Based
Chromium (III) total Cr	2.13E+03	GWP	GWP	1.00E-01	Ingestion	MCL
Chromium (VI)	7.90E+00	GWP	GWP	3.13E-02	Ingestion	Risk-Based
Chrysene	3.34E+01	GWP	GWP	7.65E-03	Ingestion	Risk-Based
Copper	9.21E+02	GWP	GWP	1.30E+00	Ingestion	MCL
Cyanide (as Sodium Cyanide)	3.68E-01	GWP	GWP	2.00E-01	Ingestion	MCL
Dacthal	1.59E+01	Subsurface Soil	Child	1.04E-01	Ingestion	Risk-Based
Dalapon (2,2-dichloropropionic acid)	4.57E-01	GWP	GWP	2.00E-01	Ingestion	MCL
DDD[d]	2.44E+00	Surficial Soil	Age-Adjusted	2.33E-04	Ingestion	Risk-Based
DDE[e]	1.72E+00	Surficial Soil	Age-Adjusted	1.64E-04	Ingestion	Risk-Based
DDT[f]	4.03E-01	GWP	GWP	1.64E-04	Ingestion	Risk-Based
Demeton	1.29E-03	GWP	GWP	4.17E-04	Ingestion	Risk-Based
Dibenzo(a,h)anthracene	4.22E-02	Surficial Soil	Age-Adjusted	7.65E-06	Ingestion	Risk-Based
Dibenzofuran	3.05E+00	GWP	GWP	2.09E-02	Ingestion	Risk-Based
Dibromochloromethane	2.02E-03	GWP	GWP	6.65E-04	Ingestion	Risk-Based
Dichlorodifluoromethane	3.10E+00	Subsurface Soil	Child	2.02E-01	Indoor Inhalation	Child
Dieldrin	1.33E-03	GWP	GWP	3.49E-06	Ingestion	Risk-Based
Diethylphthalate	2.75E+01	GWP	GWP	8.34E+00	Ingestion	Risk-Based
Dimethylphthalate	2.71E+02	GWP	GWP	1.04E+02	Ingestion	Risk-Based
Di-n-butyl phthalate	3.10E+01	GWP	GWP	1.04E+00	Ingestion	Risk-Based
Di-n-octyl phthalate	1.83E+03	Surficial Soil	Child	4.17E-01	Ingestion	Risk-Based
Diquat	1.09E-01	GWP	GWP	2.00E-02	Ingestion	MCL

INITIAL DEFAULT TARGET LEVELS (IDTLs)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Basis for Ingestion Target/ Inhalation Critical Receptor$_i$
Disulfoton	6.68E-02	GWP	GWP	4.17E-04	Ingestion	Risk-Based
Diuron	2.16E-01	GWP	GWP	2.09E-02	Ingestion	Risk-Based
Endosulfan	2.49E+00	GWP	GWP	6.26E-02	Ingestion	Risk-Based
Endothall	3.35E-01	GWP	GWP	1.00E-01	Ingestion	MCL
Endrin	3.35E-01	GWP	GWP	2.00E-03	Ingestion	MCL
Eptam	1.39E+00	GWP	GWP	2.61E-01	Ingestion	Risk-Based
Ethylbenzene	1.02E+01	GWP	GWP	7.00E-01	Ingestion	MCL
Ethylene dibromide(EDB)	1.43E-04	GWP	GWP	5.00E-05	Ingestion	MCL
Fluoranthene	3.64E+02	GWP	GWP	4.17E-01	Ingestion	Risk-Based
Fluorene	5.48E+01	GWP	GWP	4.17E-01	Ingestion	Risk-Based
Fluoride (as Sodium Fluoride)	7.36E+00	GWP	GWP	4.00E+00	Ingestion	MCL
Glyphosate	4.48E+01	GWP	GWP	7.00E-01	Ingestion	MCL
Heptachlor	1.08E-03	Subsurface Soil	Age-Adjusted	4.00E-04	Ingestion	MCL
Heptachlor epoxide	2.61E-02	GWP	GWP	2.00E-04	Ingestion	MCL
Hexachlorobenzene	4.28E-02	Subsurface Soil	Age-Adjusted	1.00E-03	Ingestion	MCL
Hexachlorobutadiene	3.81E-02	Subsurface Soil	Age-Adjusted	7.16E-04	Ingestion	Risk-Based
Hexachlorocyclopentadiene	1.17E-02	Subsurface Soil	Child	7.30E-03	Indoor Inhalation	Child
Hexachloroethane	1.38E-01	GWP	GWP	3.99E-03	Ingestion	Risk-Based
Hexazinone	8.84E-01	GWP	GWP	3.44E-01	Ingestion	Risk-Based
Hydrogen Sulfide	3.10E-02	Subsurface Soil	Child	1.79E-02	Indoor Inhalation	Child
Indeno(1,2,3-cd)pyrene	4.22E-01	Surficial Soil	Age-Adjusted	7.65E-05	Ingestion	Risk-Based
Iron (as Iron Oxide)	5.76E+00	GWP	GWP	3.13E+00	Ingestion	Risk-Based
Isophorone	1.40E-01	GWP	GWP	5.88E-02	Ingestion	Risk-Based
Isopropylbenzene (Cumene)	3.46E+00	GWP	GWP	1.04E+00	Ingestion	Risk-Based
Lead	4.96E+01	GWP	GWP	1.50E-02	Ingestion	MCL
Manganese	2.23E+02	GWP	GWP	2.50E-01	Ingestion	Risk-Based
Mercury	5.09E-03	GWP	GWP	2.00E-03	Ingestion	MCL
Methoxychlor	5.52E+01	GWP	GWP	4.00E-02	Ingestion	MCL
Methylene Chloride	1.69E-02	GWP	GWP	7.45E-03	Ingestion	Risk-Based
Metolachlor	8.43E+00	GWP	GWP	1.56E+00	Ingestion	Risk-Based
Metribuzin	7.21E-01	GWP	GWP	2.61E-01	Ingestion	Risk-Based

INITIAL DEFAULT TARGET LEVELS (IDTLs)

CHEMICALS OF CONCERN	SOIL			GROUNDWATER		
	IDTL [mg/kg]	Critical Pathway	Critical Receptor	IDTL [mg/L]	Critical Pathway	Basis for Ingestion Target/ Inhalation Critical Receptor$_i$
MTBE[g]	6.67E-02	GWP	GWP	3.10E-02	Ingestion	Risk-Based
Naphthalene	1.15E+00	Subsurface Soil	Child	2.09E-01	Ingestion	Risk-Based
Nickel	5.91E+01	GWP	GWP	2.09E-01	Ingestion	Risk-Based
Nitrate (as Sodium Nitrate)	1.84E+01	GWP	GWP	1.00E+01	Ingestion	MCL
Nitrite (as Sodium Nitrite)	1.84E+00	GWP	GWP	1.00E+00	Ingestion	MCL
Nitrobenzene	2.18E-02	GWP	GWP	5.21E-03	Ingestion	Risk-Based
N-Nitrosodimethylamine	2.09E-06	GWP	GWP	1.10E-06	Ingestion	Risk-Based
N-Nitrosodi-n-propylamine	1.81E-05	GWP	GWP	7.98E-06	Ingestion	Risk-Based
N-Nitrosodiphenylamine	8.80E-02	GWP	GWP	1.14E-02	Ingestion	Risk-Based
Oxamyl (Vydate)	3.86E-01	GWP	GWP	2.00E-01	Ingestion	MCL
Pentachlorophenol	9.07E-03	GWP	GWP	1.00E-03	Ingestion	MCL
Phenanthrene	7.90E+01	GWP	GWP	3.13E-01	Ingestion	Risk-Based
Phenol	7.36E+00	GWP	GWP	3.13E+00	Ingestion	Risk-Based
Picloram	2.95E+00	GWP	GWP	5.00E-01	Ingestion	MCL
Prometon	7.04E-01	GWP	GWP	1.56E-01	Ingestion	Risk-Based
Pyrene	3.59E+02	GWP	GWP	3.13E-01	Ingestion	Risk-Based
sec-Butylbenzene	1.18E+00	Subsurface Soil	Child	1.04E-01	Ingestion	Risk-Based
Selenium	2.03E+00	GWP	GWP	5.00E-02	Ingestion	MCL
Silver	1.89E-01	GWP	GWP	5.21E-02	Ingestion	Risk-Based
Simazine	1.08E-02	GWP	GWP	4.00E-03	Ingestion	MCL
Styrene	1.83E+00	GWP	GWP	1.00E-01	Ingestion	MCL
Terbutryn	3.21E-01	GWP	GWP	1.04E-02	Ingestion	Risk-Based
tert-Butylbenzene	8.59E-01	Subsurface Soil	Child	1.04E-01	Ingestion	Risk-Based
Tetrachloroethene	3.02E-02	Subsurface Soil	Child	5.00E-03	Ingestion	MCL
Thallium	1.55E+00	GWP	GWP	2.00E-03	Ingestion	MCL
Toluene	4.89E+00	GWP	GWP	1.00E+00	Ingestion	MCL
Total Xylenes	1.68E+00	Subsurface Soil	Child	4.46E+00	Indoor Inhalation	Child
Toxaphene	3.26E-01	Surficial Soil	Age-Adjusted	3.00E-03	Ingestion	MCL
Trichloroethene	1.59E-03	Subsurface Soil	Child	1.79E-03	Indoor Inhalation	Age-Adjusted
Trichlorofluoromethane	1.09E+01	Subsurface Soil	Child	2.11E+00	Indoor Inhalation	Child
Vinyl Chloride	9.63E-03	GWP	GWP	2.00E-03	Ingestion	MCL
Zinc	8.86E+02	GWP	GWP	3.13E+00	Ingestion	Risk-Based

[a]Ground Water Protection Via Soils Leaching to Groundwater

[b]Maximum contaminant level

[c] Benzene hexachloride

[d] Dichloro diphenyl dichloroethylene

[e] 1,1-Dichloro-2,2-bis(p-chlorophenyl) ethane

[f] Dichloro diphenyl trichloroethane

[g] Methyl tert-butyl ether

[h] Tetrachloro di benzo-p-dioxin

[i] 4,5,-Trichlorophenoxy propionic acid

[j] For the ingestion pathway the source of the target level is indicated (MCL or a risk-based calculation); for the inhalation pathway the critical receptor is indicated (child or age-adjusted individual).

Yellow shaded cells represent changes in values due primarily to changes in toxicity factors.

Blue shaded cells represent changes in values due to Johnson and Ettinger model modifications.

Orange shaded cells represent changes in values due to correction of typographical changes in the original REM.